PHOSPHORUS IN A HILL PERMANENT GRASSLAND ECOSYSTEM IN SPRING BY PRINCIPAL COMPONENTS & CLASSIFICATION ANALYSIS

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Abstract
The aim of the present study was to extract information regarding the phosphorus content in a permanent grassland ecosystem, influenced anthropic by two different agricultural systems: exclusive mineral fertilisation and sheep manure farming management. The research was made in spring, in a hill region of Romanian Banat. Principal Components & Classification Analysis (PC&CA) was performed for statistical interpretation of data. The first two principal components described around 90% of the total variance. Forages total phosphorus content was positive correlated to the sheep manure farming system (0.84), and to the grassland soil phosphorus, total content (0.88) and mobile form (0.65).

Introduction
The phosphorus in vegetal cell is required for the proteic metabolism, in the glucides transfer to the root [1], in biological oxidation and photosynthesis processes [2], in the transmission of hereditary characters [3], ensuring the formation of buffer systems, etc. [4]. An optimum phosphorus content in plants stimulates their regeneration after forage harvesting [1].So, it is justified the necessity to monitorthe phosphorus content in grassland ecosystem and supplementing it in case of necessity [5, 7]. For the environment health it is recommended to verify the existing phosphorus in grassland soil, to assure the phosphorus balance: inputs versus outputs [12]. The application of mineral and/or organic fertilizers influences positively the grassland forage production [11], being preferable to use organic fertilisers, for replace or reduce to the minimum the mineral fertilisers application [3]. The aim of this issue was to quantify in spring the quantity of phosphorus content in a Banat hill permanent grassland ecosystem, after sheep manure or mineral fertilizers application since 2003.

Experimental
A grazed and mowed hill permanent grassland, situated in Romanian Banat County (45°12'N; 21°60'E) on a Calcic Luvisol, was organisedas experimental field in 2003. A complete randomised block design with 5 replications was used; 25 m^2/trial. The fermented sheep manure was applied at two years in three different trials: 20 t/ha, 40 t/ha and 60 t/ha (P2, P3, and P4). Total phosphorus content of sheep manure was 5156 ppm (at U=61%). Mineral fertilisers were applied yearly: NPK complex, ammonium nitrate, superphosphate, and potassium salt. Doses of 100 kg/ha N + 50 kg/ha P_2O_5 + 50 kg/haK_2O were applied in P5; 150 kg/ha N + 50 kg/ha P_2O_5 + 50 kg/ha K_2O in P6 trial; (100+100) kg/haN +50 kg/ha P_2O_5 + 50 kg/ha K_2O in P7. P1 trial was not fertilised. In the studied region the clime is temperate continental with Mediterranean influences [9]. In 2008 theannual average temperature was around 12°C and annual average rainfall around 802 mm [14].
The floristic composition of the permanent grassland covering in May 2008 was determined using gravimetric method. The plants samples were harvested from 1 m^2 for each grassland trial, at 3 cm above soil. For the multivariate matrix computational process was used the following floristic code: 0 for 0%; 1 for 0.1-10%; 2 for 11-20%; 3 for 21-30%; 4 for 31-40%; 5 for 41-50%; 6 for 51-60% species participation.

Humus content was determined by Walklay – Black – Gogoasa method; and available phosphorus (mobile form) of soil was quantified using Egner-Riehm-Domingo method [13]. Total calcium content was determined by atomic absorption spectrometry [6] and total phosphorus content at 450 nm [10]. PC&CA was performed for multidimensional data analysis by StatSoft - STATISTICA VERSION 10.

Results and discussion

The *Festuca rupicola* grass participation in permanent grassland covering, after floristic code application, were 4, 2, 1, 1, 6, 2, 1 for P1, P2, P3, P4, P5, P6, respectively P7. In *Lathyrus pratensis*leguminous case the values were 1, 0, 0, 1, 0, 0, 1, while for *Trifolium repens* were 1, 4, 5, 5, 0, 0, 1 in P1, P2, P3, P4, P5, P6, respectively P7 trials.

The total calcium content of grassland forages varied between 6579 ppm (P6) to 25535 ppm (P2). In forages cut from organic P3 and P4 trials, the total calcium content was 21237ppm, respectively 18521 ppm, and for the mineral fertilised trials P5 and P7 were 7566 ppm and 6799 ppm. In forages harvested from unfertilised conditions the total calcium content was 14911 ppm, smaller than sheep manure management, and higher than mineral fertilized trials.

Total phosphorus content of grassland forages from P1 to P7 trials was556 ppm, 890 ppm, 1237 ppm, 1289ppm, 875 ppm, 821 ppm, respectively 967 ppm. In grassland soil, the total phosphorus content in P1 – P7 ecological conditions were: 65 ppm, 113 ppm, 133 ppm, 166ppm, 122 ppm, 130 ppm, and 133 ppm, while mobile form of phosphorus quantified 58.3ppm, 53.6 ppm, 61.6 ppm, 87.6 ppm, 61.7 ppm, 49.2 ppm and 70.7 ppm.

Soil grassland pH in spring of 2008 varied in range 6.1 – 6.3 in organic farming system (P2 – P4), and 5.7 – 5.9 in exclusive mineral fertilised trials (P5 – P7), reported to the conditions of unfertilised case (P1) with 6.1. Considering this information, it is obviously that mineral fertilizers application acidified the grassland soil in raining and temperature natural conditions of Romanian Banat.

The grassland soil humus contentsin P1 – P7 trials, differentiate reported to the anthropic influence of fertilizers application, were: 5.8 %, 5.6 %, 6.1 %, 7.2 %, 6.5 %, 6.2 % and 6.2 %.

All these experimental data were used to perform the matrix, following the procedures of multidimensional PC&CA. The active variables were: forages total calcium content (ppm); forages total phosphorus content (ppm); soil total phosphorus content (ppm) and soil phosphorus mobile form (ppm);soil pH; soil humus (%); and the fertilisation data. The supplementary variables were considered the participation in grassland covering of *Festuca rupicola*, *Lathyrus pratensis* and *Trifolium repens*. The matrix cases were considered all the seven trials. The matrix data were interpreted via the correlation matrix.

The eigenvalues of the PC1 and PC2 were 5.62 and 3.36. In accordance with the data, the first two principal components described around 90% of the total variance. High positive influence in PC1 had forages total calcium content (0.86), forages total phosphorus content (0.61), soil pH (0.97), *Trifolium repens* participation in spontaneous covering (0.94), and sheep manure fertilisation (0.92). The mineral fertilisation data had high negative influence in PC1, varying from -0.86 to -0.90. Soil phosphorus mobile form had a positive contribution in PC1 (0.51). The highest negative influence in PC2 had: soil total phosphorus content (-0.89); soil humus (-0.87); forages total phosphorus content (-0,69) and soil phosphorus mobile form (-0.69). The cases and variables distribution on PC1 x PC2 plane are shown in Figure 1 and Figure 2.

Using the PC&CA facilities, it is obviously that all the three cases of the ecological conditions of grassland ecosystem, modified anthropic by exclusive mineral fertilisation (P5, P6 and P7), present similitudes and were classified in a distinct group reported to the organic farming system (P2, P3 and P4) and unfertilised trial (P1). In the soil and clime conditions of Banat spring, the sheep manure fertilisation system play a key role to the total phosphorus content of forages, heaving a significant statistic correlation (0.84). Organic farming system influences

positively also the soil pH (0.82) and the forages total calcium content (0.66).

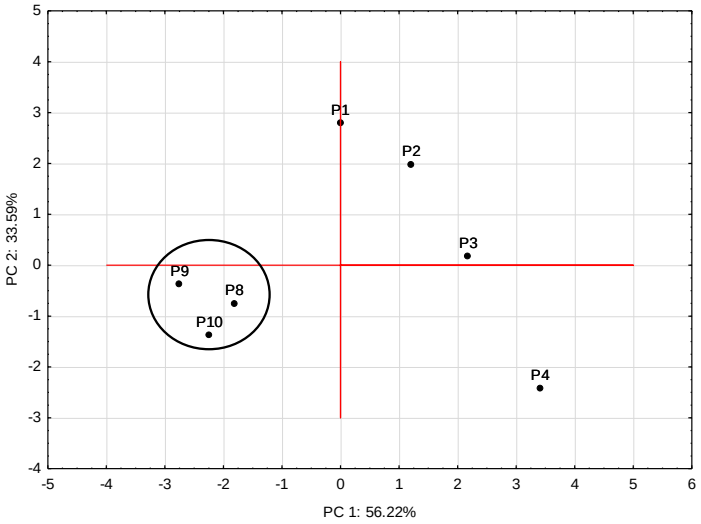

Figure 1.PC&CA cases distribution on PC1 x PC2 plane

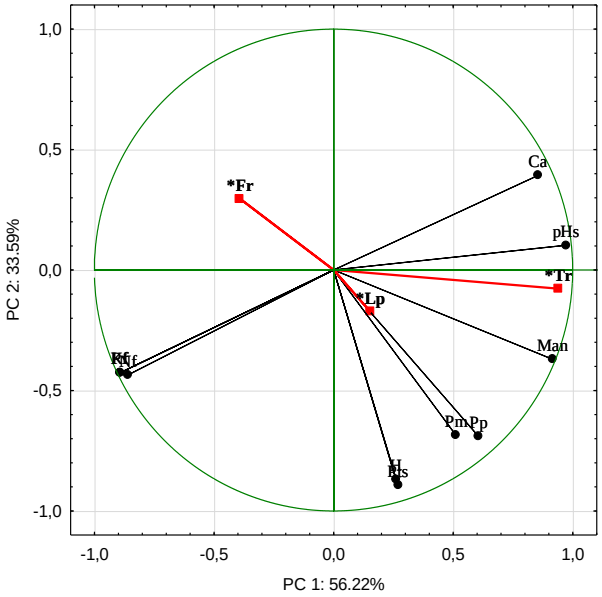

Figure 2. PC&CA variables distribution on PC1 x PC2 plane

The variables correlations reflected o positive coefficient between total phosphorus content of forages and soil total phosphorus content and soil mobile formof phosphorus (0.88, respectively 0.65). A positive correlation coefficient was find also between total content and mobile form of soil phosphorus (0.60). The soil mobile form of phosphorus was positive influenced by the organic fertilizer application (0.65) and soil humus content (0.81). Analogously, the soil total phosphorus contentwas positive correlated to the soil humus (0.75). With regard to the selected plants participation in the permanent grassland covering, it can say that *Trifolium repens*had the highestpositive correlation to the sheep manure application in organic farming system (0.92). *Lathyrus pratensis* participation to the grassland floristic composition was positively correlated to the mobile form of soil phosphorus(0.66).

Conclusion

In Banat environmental conditions of 2008 spring the organic farming system with fermented sheep manure had a positive influence on the forages total phosphorus content (0.84). Positive

correlation coefficients were found between forages total phosphorus content and soil total phosphorus content (0.88) and soil mobile form of phosphorus (0.65).
In studied hill permanent grassland, the soil total phosphorus content and soil mobile form of phosphorus had a positive correlation (0.60). The soil humus influenced also positively the soil mobile form phosphorus (0.81) and the soil total phosphorus content (0.75) in the hill Romanian Banat grassland ecosystem.

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